CLAIMS:

1. An optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal output from an add/drop module adding at least one channel to and dropping at least one channel from a signal input thereto, comprising:

a gain element optically coupled to the add/drop module and to an add channel port receiving the at least one channel to be added;

said gain element imparting optical gain to the at least one channel received from the add channel port;

a controller operatively coupled to said gain element,

said controller receiving a dropped channel power measurement of the at least one dropped channel dropped from the add/drop module;

said controller determining an add path amplification value based on the dropped channel power measurement, a through loss associated with a signal passing through the add/drop module, a drop loss associated with a signal travelling a drop path of the add/drop module; and an add loss associated with a signal travelling an add path of the add/drop module; and

said controller controlling said gain element according to the add path amplification value.

2. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1,

said controller receiving a number of channels to be added by the add/drop module;

said controller determining the add path amplification value based on the number of channels to be added, the dropped channel power measurement, the through loss associated with a signal passing through the add/drop module, the drop loss associated with a signal travelling a drop path of the add/drop module; and the add loss associated with a signal travelling an add path of the add/drop module; and

said controller controlling said gain element according to the add path amplification value.

3. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1,

said controller receiving a number of channels to be dropped by the add/drop module;

said controller determining the add path amplification value based on the number of channels to be dropped, the dropped channel power measurement, the through loss associated with a signal passing through the add/drop module, the drop loss associated with a signal travelling a drop path of the add/drop module; and the add loss associated with a signal travelling an add path of the add/drop module; and

said controller controlling said gain element according to the add path amplification value.

4. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1,

said controller receiving a number of channels to be added and a number of channels to be dropped by the add/drop module;

said controller determining the add path amplification value based on the number of channels to be added, the number of channels to be dropped, the dropped channel power measurement, the through loss associated with a signal passing through the add/drop module, the drop loss associated with a signal travelling a drop path of the add/drop module; and the add loss associated with a signal travelling an add path of the add/drop module; and

said controller controlling said gain element according to the add path amplification value.

5. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 4,

said controller determining the add path amplification based on the following equation:

$P_{addtotal} = P_{drop} + (\text{Drop Loss} + \text{Add Loss} - \text{Through Loss}) + 10\text{Log } N_{add}$

where

$P_{addtotal}$ = add path amplified power level in dBm,

P_{drop} = per channel power level of dropped signal output from drop port of add/drop module in dBm,

Through Loss = loss associated with a signal passing through the add/drop module in dBm,

Drop Loss = loss associated with a signal travelling a drop path of the add/drop module in dBm,

Add Loss = loss associated with a signal travelling an add path of the add/drop module in dBm, and

N_{add} = number of added channels.

6. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1, further comprising:

a coupler optically coupled to a drop output of the add/drop module,

an optical-to-electrical converter optically coupled to said coupler, said optical to-electrical coupler receiving a portion of light from the at least one dropped channel;

said controller determining the dropped channel power measurement from an output of said optical-to-electrical converter.

7. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1,

said controller receiving an added channel power measurement of the least one added channel being added to the input signal by the add/drop module;

said controller feedback controlling said gain element based on the added channel power measurement and the add path amplification value.

8. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1,

said gain element having a gain profile substantially matching a gain profile of a signal input to the add/drop module.

9. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1, further comprising:

an input amplifier optically coupled an input port of the add/drop module and receiving a plurality of input channels;

said gain element having a gain profile substantially matching a gain profile of said input amplifier.

10. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1, further comprising:

a drop amplifier optically coupled to the drop port of the add/drop module, said drop amplifier amplifying the dropped channels.

11. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1, further comprising:

an output amplifier optically coupled to the add/drop module;

said output amplifier amplifying the output of the add/drop module.

12. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 11,

said output amplifier performing gain flattening amplification for the signal output from the add/drop module.

13. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1,

wherein said gain element includes an add amplifier,

said controller controlling said add amplifier according to the add path amplification value.

14. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1,

wherein said gain element includes an add amplifier and a variable optical attenuator,

said controller controlling said variable optical attenuator according to the add path amplification value.

15. The optical communications apparatus for power balancing a wavelength division multiplexed (WDM) signal according to claim 1,

wherein said gain element includes an add amplifier and a variable optical attenuator, said controller controlling said variable optical attenuator and said add amplifier according to the add path amplification value.

16. A method of power balancing a wavelength division multiplexed (WDM) signal output from an add/drop module adding at least one channel to and dropping at least one channel from a signal input thereto, comprising:

receiving a dropped channel power measurement of the least one dropped channel dropped from the add/drop module;

determining an add path amplification value based on the dropped channel power measurement, a through loss associated with a signal passing through the add/drop module, a drop loss associated with a signal travelling a drop path of the add/drop module; and an add loss associated with a signal travelling an add path of the add/drop module; and

controlling an add path amplification of the add path according to the add path amplification value.

17. The method according to claim 16, further comprising:

receiving a number of channels to be added by the add/drop module; and

determining the add path amplification value based on the number of channels to be added, the dropped channel power measurement, the through loss associated with a signal passing through the add/drop module, the drop loss associated with a signal travelling a drop

path of the add/drop module; and the add loss associated with a signal travelling an add path of the add/drop module.

18. The method according to claim 16, further comprising:

receiving a number of channels to be dropped by the add/drop module; and

determining the add path amplification value based on the number of channels to be dropped, the dropped channel power measurement, the through loss associated with a signal passing through the add/drop module, the drop loss associated with a signal travelling a drop path of the add/drop module; and the add loss associated with a signal travelling an add path of the add/drop module.

19. The method according to claim 16, further comprising:

receiving a number of channels to be added and a number of channels to be dropped by the add/drop module; and

determining the add path amplification value based on the number of channels to be added, the number of channels to be dropped, the dropped channel power measurement, the through loss associated with a signal passing through the add/drop module, the drop loss associated with a signal travelling a drop path of the add/drop module; and the add loss associated with a signal travelling an add path of the add/drop module.

20. The method according to claim 19, further comprising:

determining the add path amplification based on the following equation:

$$P_{addtotal} = P_{drop} + (\text{Drop Loss} + \text{Add Loss} - \text{Through Loss}) + 10\text{Log}\, N_{add}$$

where

$P_{addtotal}$ = add path amplified power level in dBm,

P_{drop} = per channel power level of dropped signal output from drop port of ADM module in dBm,

Through Loss = loss associated with a signal passing through the add/drop module in dBm,

Drop Loss = loss associated with a signal travelling a drop path of the add/drop module in dBm,

Add Loss = loss associated with a signal travelling an add path of the add/drop module in dBm, and

N_{add} = number of added channels.

21. The method according to claim 16, further comprising:

substantially matching a gain profile of the add path with a gain profile of a signal input to the add/drop module.

22. The method according to claim 16, further comprising:

preamplifying a signal input to the add/drop module;

said preamplification step imparting a gain profile substantially similar to a gain profile of the add path.

23. The method according to claim 16,

wherein the add path includes an add amplifier;

said controlling step controlling a gain of the add amplifier.

24. The method according to claim 16,

wherein the add path includes an add amplifier and a variable optical attenuator optically coupled thereto;

said controlling step controlling a gain of the add amplifier and/or an attenuation of the variable optical attenuator.

25. The method according to claim 16,

amplifying the output of the add/drop module with gain-flattening amplification.